

Subject: phila.9.88 [T-214

Notes on Changing images of the body.

Phila. Libraries, 9/22/88

My challenge was to relate my experience in molecular biology to artefacts of the kind that are magnificently collected in your exhibition.

We have the problem that, as science becomes more specialized, it becomes more arcane, less accessible to the layman, however broad his or her general education, more alienated from everyday experience.

We can all relate this portrait

Audubon's Osprey and Fish

to the theoretical developments in Darwin's text, and this text in turn is readable by a large audience.

But as we look in ever more detail what can be found in that bird, that fish

Cell

we come in contemporary terms to displays like this:

DNA sequences -- cover of handbook

or, slightly more colorfully related to the observables of the laboratory:

ATCG bands:

As we have gained enormously in scientific precision, we have lost a good deal in comprehensibility. At risk also is that insight into how the world is and can be run that is essential for authentic participation in a democratic society.

I will argue that DNA is central to the contemporary image of the body; for 35 years we could assert that the evolution of man has as its consequence the information stored in about 2 meters, 3 billion nucleotide units of DNA. So I will elaborate a bit on that, on what DNA is and how it is represented, and then comment briefly on the extent to which that abstraction is sufficient as an image of the body.

Let me start again with SLIDES of a cell. The DNA in that nucleus is not devoid of colorful connotation:

Much discussion of the project to sequence the human genome. Will that give us the information needed to prescribe the human body, the implied promise of the proponents?

There will be a good deal of disillusion and disappointment if that is taken too literally. The billion dollars or so premised as the price tag will give us something like a million pages of the data I showed you for the mitochondrial DNA. Many insights will be buried in that, insights that can be related to wide range of other investigation. But to get a reasonable understanding of a single gene and its products is a \$10 MM exercise. The 100,000 genes will then come to a staggering \$trillion in monetary price tag, without beginning to embrace the complexity of interactions among the developmental and regulatory pathways. Not to mention the cognitive challenge of dealing with such orders of complexity. We should set some priorities among parts of the genome in allocating resources, when the comprehensive total is so immense.

The reductionist-mechanistic approach to the body that was given great impetus in the last century is the only heuristic that has given reliable, reproducible knowledge of the detail of the body. Ramparts thought impregnable like the mechanism of gene reproduction have yielded to straightforward chemical analysis in a fashion that would have astounded the most enthusiastic cytologists of 50 years ago. Will we be able to "reduce" every aspect of human structure and behavior to the elementary rules of physics and chemistry? Will "consciousness" be as amenable to physical chemistry as "gene reproduction" has been?

As a heuristic for further enquiry, I would be inclined to suggest "yes", but that is not the same as to insist on reducibility as an article of faith, beyond the point where it can be tested by tangible, feasible experiments. The 3 billion units of DNA that "define" the human genome are sufficient information in the sense that they have been the object of the evolutionary process, operating in the actual universe we inhabit, and its laws of physics and chemistry. Had we perfect knowledge of those laws, and a computer of unbounded capacity we might expect to predict what organism would emerge from any given DNA complex. (We would also have to keep in mind that the DNA must also operate in the context of a preexistent cell, an object of extraordinary complexity: that cell in turn is the joint product of its predecessor and its current DNA content). Such predictions are the final test of any scientific theory. But we have neither that perfect knowledge nor that boundless computer; and the solution of nonlinear differential equations with a 100,000 variables is beyond the expectation of contemporary science. At this moment, we have a virtually intractable problem trying to predict just how a single protein molecule will fold, a sequence of a mere 100 and odd amino acid units. We therefore ought to retain a certain humility about how far reductive analytic science can go in practice in dealing with systems as complex as the cell, or the brain -- or the determinants that have to be taken account of before we can discuss that residual we call free will. The biological organismic system must have a certain dissectability and linearity, or gradual evolution could not have succeeded; but we do not believe that evolution has always been so smooth. And we are sometimes puzzled at major discontinuities in evolutionary change that speak to the contrary.

The occasional scientist who does so is, then, inappropriately smug and offensive when he refers to the human body as a "mere machine". The mechanistic metaphor remains our most powerful guide to the scientific analysis of the body, seeking an understanding of it, part by part. But there is nothing "mere" about a machine whose complexity still presents such extraordinary challenges to analysis. As with our understanding of the cosmos, the metaphor is an observationally well-founded faith that the universe is subject to an order of natural law, not demons, ghosts or demi-gods. That the cell is DNA and protein subject to as much chemical understanding as our tools permit, not a protoplasm imbued with an immanent vital force. Until we reach the limits of that understanding we may still enjoy dealing with our own personalities, and others', in terms that embrace not only DNA but social organization, intuition, affect, humanistic and esthetic insight: wonderfully displayed in that Borgesian Universe we call our Library.